

## CHAPTER 5

### STORMWATER TREATMENT BMPs

#### Standard for Bioretention Systems

##### Definition

Bioretention areas consist of an excavation backfilled with a sand/soil mixture and planted to native vegetation, oriented to receive and filter storm runoff from impervious areas and lawns.

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##### Purpose

Bioretention systems are used to remove a wide range of pollutants, such as suspended solids, nutrients, metals, hydrocarbons, and bacteria from stormwater runoff. They can also be used to reduce peak runoff rates and improve infiltration of stormwater.

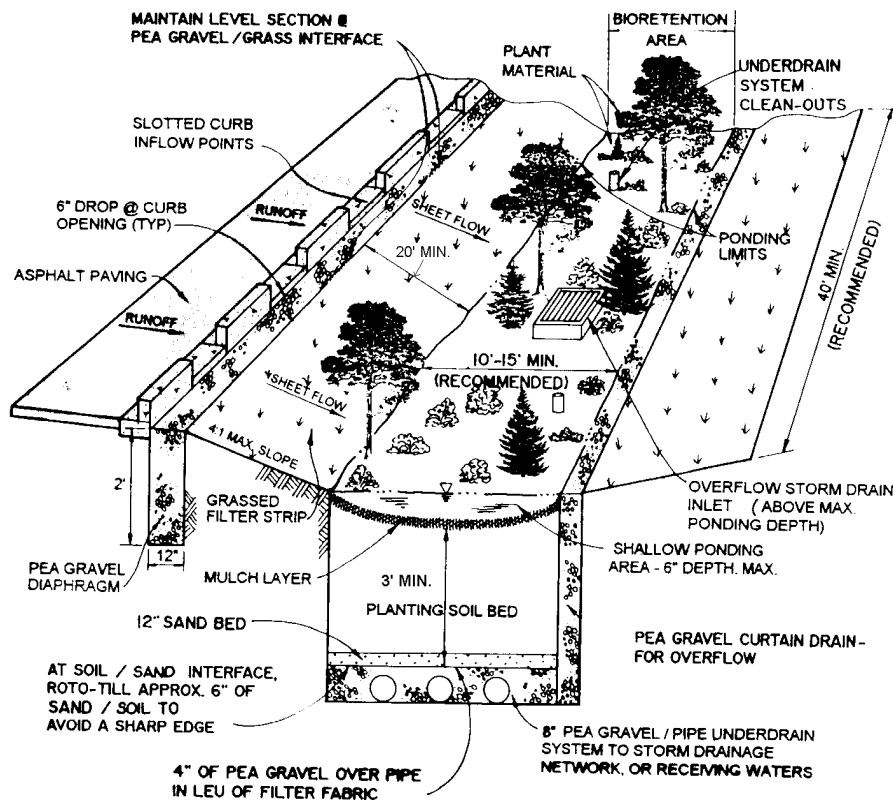
##### Conditions Where Practice Applies

Bioretention systems can be used to filter runoff from both residential and nonresidential developments. Sources of runoff can be overland flow from impervious areas or discharge diverted from a drainage pipe.

Bioretention systems are most effective if they receive runoff as close as possible to the source. Bioretention systems can be large or small and can be incorporated to handle runoff from varying watersheds throughout a development. They can be installed in median strips, parking lot islands, unused odd areas and easements, or lawn areas. When properly implemented, these systems can reduce the cost of drainage infrastructure dramatically.

Bioretention systems should **not** be planned in areas having the following characteristics:

1. The water table is within 2 feet of the filter bottom
2. Mature trees would have to be removed to build the system
3. Slopes are greater than 10%
4. Karst topography is present on the site



SOURCE: Adapted from  
Prince George's County,  
Maryland  
Design Manual, 1993

Figure 1. Typical Bioretention System

From: Claytor and Schueler, 1996

## Design Criteria

Bioretention system designs should allow for treatment of the runoff volume generated by the design storm. The minimum design storm shall be the 2 hour, 1.25" event. (water quality volume or WQV) Storage volume elevation for WQV shall be to top of overflow inlet. The system shall be designed to fully drain the ponded water in less than 72 hours.

The overall size of the bioretention area should be 5 to 7 percent of the drainage area multiplied by the *c* coefficient of the rational formula. If this sizing is infeasible in a given situation, the following MINIMUM sizing criteria shall apply (Figure 1):

- Minimum width is 10 - 15 feet (excluding filter strips)
- Minimum length is 40 feet
- Ponded area depth maximum = 6 inches.
- Planting soil minimum depth = 3 feet

#### System Components:

Pretreatment Filter Strip: This is necessary to reduce incoming velocities and capturing coarser sediments, which will extend the life of the system. The location would be either just above or just below the inflow point into the system. A sand or gravel infiltration diaphragm may also be included as part of the filter strip. Maximum flow slope is 6%. The filter strip should be vegetated with a thick cover of perennial adapted grasses, and sized as follows:

- a. Impervious parking lots: maximum 75' long flow approach length; strip 25 feet wide
- b. Intensively managed turf: maximum 150' long flow approach length; strip 20 feet wide

Intake Structure and Flow Regulator: This element performs the function of capturing and diverting the WQV storm ensuring non-erosive velocities and non-clogging with sediment and debris. Often, this will consist of an opening in the curb that pavement runoff is directed toward and through, into the bioretention area. If a retrofit, this can often be at the point of an existing catchbasin, which would be closed and the curb behind it opened to the bioretention filter strip.

Pea Gravel Curtain Drain: This element provides an overflow feature to help augment infiltration into the planting soil/sand bed. This then allows a greater portion of the WQV to be treated by the facility. The curtain drain should consist of ASTM D 448 size no. 6 1/8-1/4" diameter clean bank run gravel placed in a 12" wide trench that is 2-3 feet deep and running perpendicular across the inflow path from the flow regulation device.

Shallow Ponding Area: This component provides surface storage for the WQV. It also allows for particle settling during the detention period. Maximum ponding depth shall be six inches.

Surface Mulch Layer: The mulch layer provides an environment for plant growth by maintaining moisture, providing microorganisms, and decomposing incoming organic matter. The surface layer acts as a filter for finer particles still in suspension and maintains an environment for the microbial community to help break down urban runoff pollutants. This should consist of standard 1"-2" shredded hardwood or chips. It should be applied to a depth of 2"- 4", and replenished as needed.

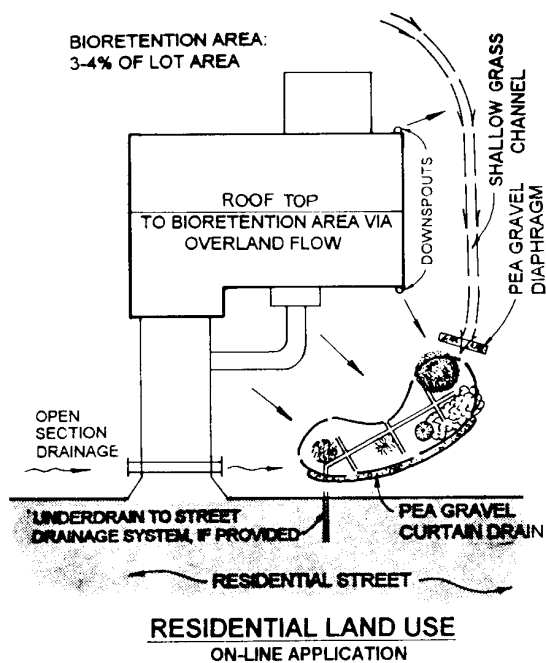
Planting Soil Bed: The planting soil bed provides the environment for water and nutrients to be made available to the vegetation. The soil particles can adsorb some additional pollutants through cation exchange, and voids within the particles can store some of the WQV. It should consist of 10-25% clay along with 30-55% silt and 35-60% sand textural classes. The pH should range from 5.5 to 6.5. This material shall be placed in lifts of 12" – 18". The total depth of the planting soil mix should be 3 to 4 feet.

Plants: The plant material takes up some of the nutrients and other pollutants. The environment around the root systems breaks down some pollutants and converts others to less harmful compounds. The use of native plant material is recommended for this component whenever possible. The goal of the planting plan should be to simulate a forest-shrub community of primarily upland type. There are three essential wetness zones within a properly built bioretention system, and plants must be selected and placed appropriately. Generally, trees should dominate the perimeter zone. The number of stems per acre should average 1,000 with tree spacing of 12 ft. and shrub spacing of 8 ft. Shrub and herbaceous species should be selected for the wetter elevations that are adapted to moisture regime and expected pollutant load.

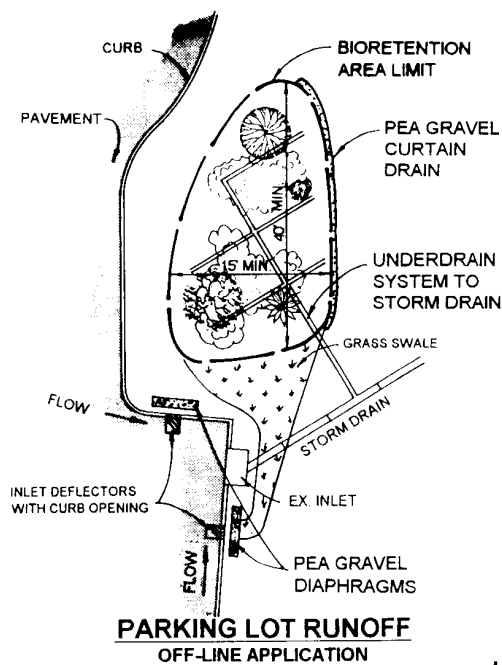
Sand Bed: The sand bed is provided to keep finer soil particles from washing out through the underdrain system and it provides an aerobic filter as a final polishing treatment media. It should be 12-18 inches thick. Sand should be clean and have less than 15% clay and silt.

Gravel Underdrain System: This element is utilized to collect and distribute the treated runoff. This system helps to keep the soil environment aerobic. It usually consists of a gravel layer extending 10 inches above and surrounding a 6" diameter perforated plastic conduit. The gravel should be clean bank run and meet ASHTO M-43 ½-2" diameter. Underdrains are optional because if soil conditions beneath the system are adequate, the filtered runoff may be entirely infiltrated. If used, they should meet AASHTO M-278 and be 6" diameter rigid schedule 40 PVC. Inflow holes should be ¼" diameter on 6" centers. The conduits should be placed 10" apart and have a minimum grade of 0.5%. Provision should be made for surface exposed cleanouts to prevent clogging.

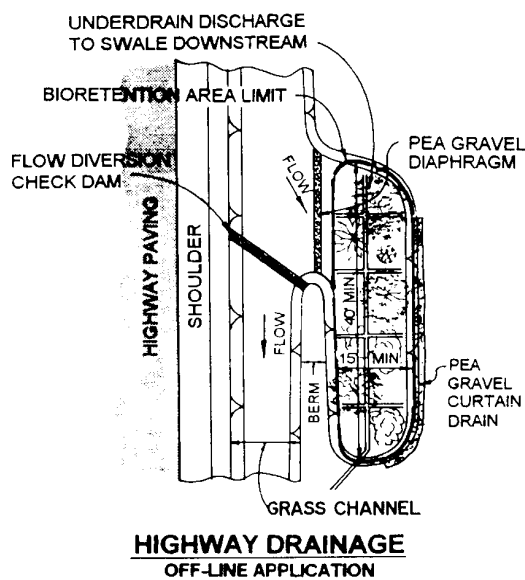
Overflow System: This component is necessary to bypass the larger storm flow volumes to the downstream receiving drainage system. This usually consist of a conventional catchbasin, inlet, or overflow channel located slightly above the shallow ponding limit. The top elevation of the inlet shall represent the required WQV.



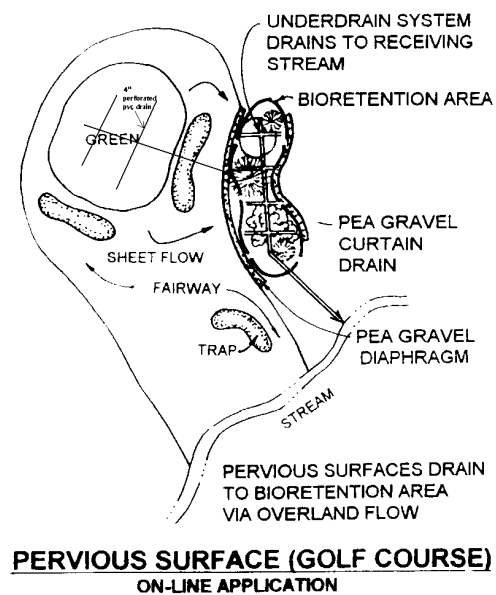
a



b



c



d

Figure 2. Typical Bioretention applications

From: Claytor and Schueler, 1996

## Considerations

Bioretention facilities are not to be installed until the contributing drainage area is completely stabilized.

Bioretention is intended primarily as a water quality practice and as such should primarily be located off-line. In some cases, some bioretention characteristics can be incorporated into an enhanced stormwater conveyance swale. (See Standard for Enhanced Swale).

## Operations and Maintenance

Monthly inspections are recommended until vegetation is established. After that, annual inspections of the systems should be adequate. Normally, accumulated sediment and debris removal (especially at the inflow point) will be the primary maintenance function. The filter strip should be mowed at least once a month during the growing season. Other possible tasks will include replacement of dead vegetation, pH regulation (usually liming), erosion repair at inflow points, mulch replenishment, unclogging subsurface drain, and repair of overflow catchbasin or conduit.

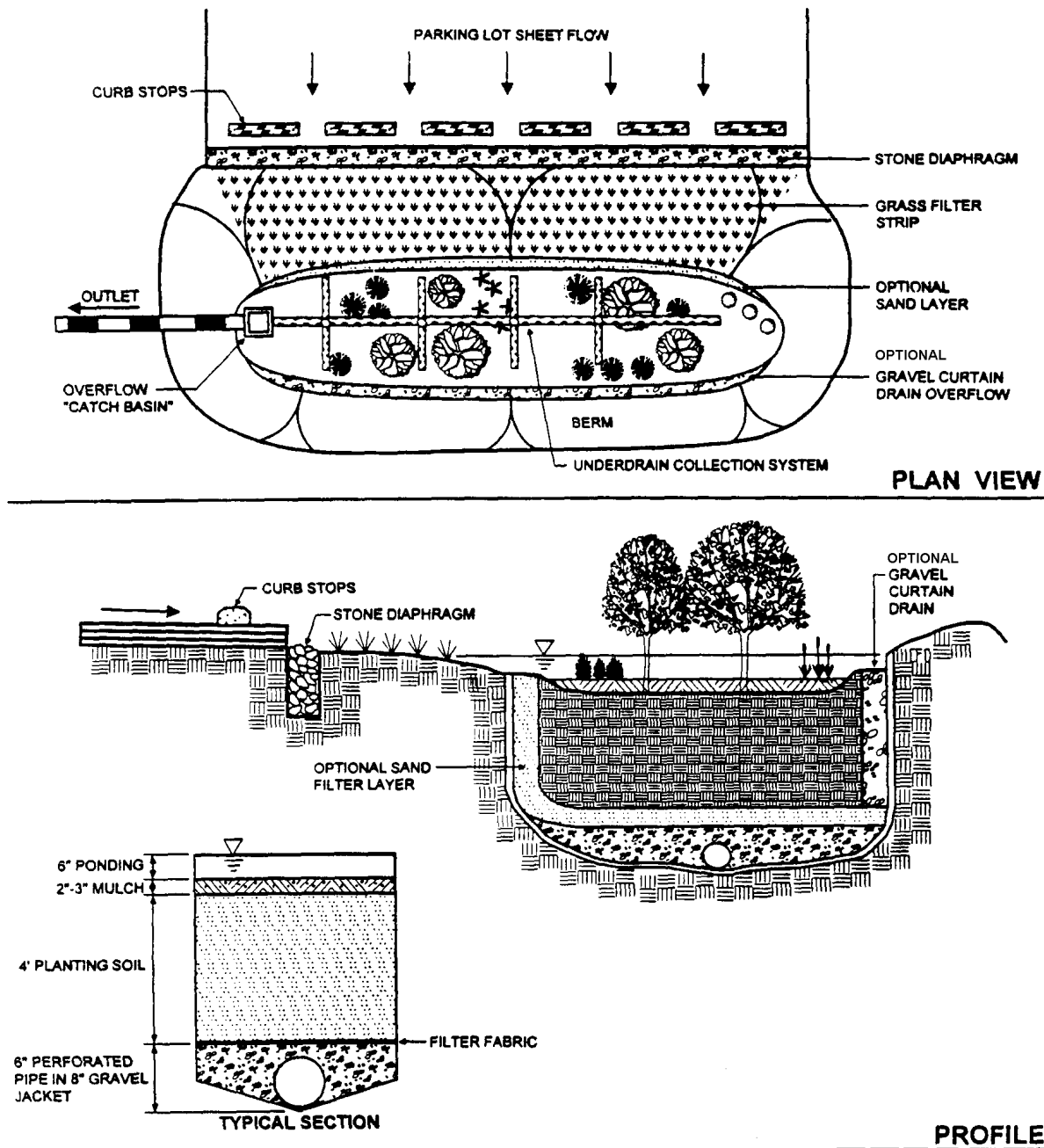


Figure 3. Another possible Bioretention design

From: State of Maryland DoE, 1999

## References

Claytor, R and Schueler, T., 1996. Design of Stormwater Filtering Systems. The Center for Watershed Protection. Ellicott City, MD.

Pennsylvania Assn. Of Cons. Districts, CH2MHill et al, 1998: Bioretention Standard and Specification, Pennsylvania Handbook of Best Management Practices for Developing Areas. Harrisburg, PA.